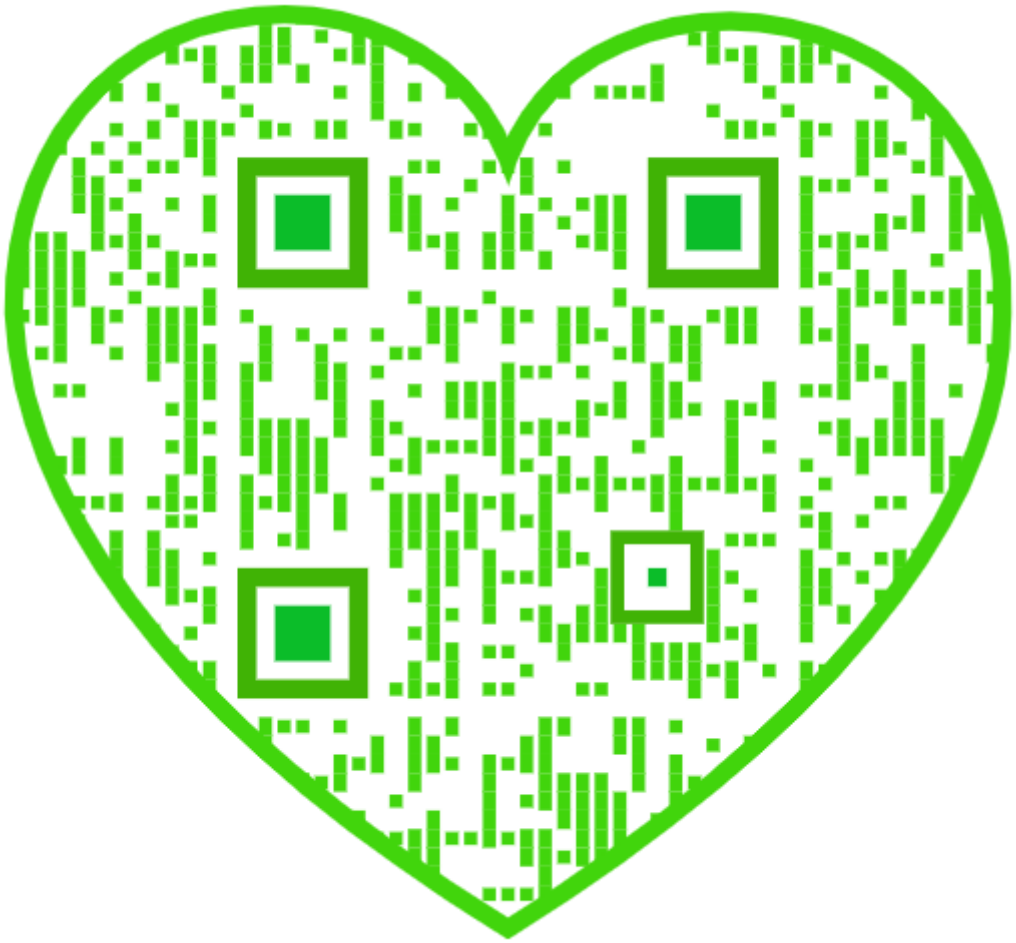

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LATE-BLIGHT TUBER ROT OF THE POTATO

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UNITED STATES DEPARTMENT OF AGRICULTURE
DEPARTMENT CIRCULAR 220

Contribution from the Bureau of Plant Industry
(Office of Cotton, Truck, and Forage Crop Disease Investigations)
WM. A. TAYLOR, Chief

Washington, D. C. May, 1922

WASHINGTON : GOVERNMENT PRINTING OFFICE : 1922

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WHAT IS LATE-BLIGHT TUBER ROT?

LATE-BLIGHT tuber rot is a disease of the potato which is caused by a mold or fungus.[1] This fungus also attacks the tops of the potato plant and causes the disease known as late-blight.

WHAT IS THE EFFECT OF THE DISEASE ON TUBERS?

Late-blight tuber rot makes affected tubers unsalable, or at least lowers their selling price, and often leads to their complete decay in the field, in transit, or in storage.

In the earliest stages the disease is marked by brownish or purplish spots, which, as development continues, become shrunken, darker colored, and finally purplish black. Late-blight tuber rot does not usually extend more than one-eighth to one-fourth of an inch beneath the skin, although it sometimes occurs within the tuber at the stem end as a broad brown ring, or in advanced stages the entire tuber changes into a wrinkled mass. The diseased tissues are dry, firm, and

[1] This fungus is known as *Phytophthora infestans*. A fungus (plural, fungi) is a small, simple plant which lacks the green color found in more complex plants, such as our orchard, field, and garden crops. Molds, yeasts, toadstools, and mushrooms are good examples of fungi. Fungi can not make their own food, as green plants do, and many of them obtain it from living plants or their dead remains. Those fungi which obtain their food and energy from living plants are known as parasites, while the plants upon which they grow and feed are known as their hosts. Such fungi usually cause harmful changes in the structure, composition, and activities of their hosts, which are known as lesions. Such changes in the affected plant constitute disease. Thus, in late-blight rot of the potato tuber the fungus *Phytophthora infestans* is the parasite which attacks and feeds upon the host, the potato tuber, causing dry-rot lesions, which are manifestations of the disease.

chocolate-brown in color. (Pl. I.) The disease is usually a dry rot and is wet and soft only when the affected tubers are exposed to very moist conditions. Under such circumstances white tufts of the fungus appear at breaks in the skin and there produce the seed bodies of the fungus, which are known as spores. The diseased spots disfigure the tubers and lead to waste in paring.

The most serious thing about the disease on tubers is that it opens the way for bacteria and other fungi which rot the tuber much more rapidly than the late-blight fungus does. If bacteria get in through diseased spots, a very wet, soft or slimy and foul-smelling rot results. This usually happens under warm moist conditions. If other fungi (usually Fusarium) follow it, an odorless rot results which may be wet or dry, depending upon temperature and moisture conditions.

WHAT IS THE EFFECT OF LATE-BLIGHT ON THE PLANT?

Late-blight on the plants reduces the yield and under favorable weather conditions may cause the complete loss of entire fields. In the earliest stages it is marked by water-soaked pale spots on the leaves and stems. On the leaves the spots often begin at the leaf margin. Later these spots wilt and blacken. (Pl. II.) In dry weather they shrivel and dry up. When the weather is warm and moist the spots enlarge rapidly, and one spot may kill an entire leaf in one to four days. Under such conditions a white coating of the fungus grows on the lower or upper side of affected leaves and on the stems and produces seed bodies, or spores, in great numbers.

WHEN AND WHERE DOES THE DISEASE OCCUR?

The disease may cause serious damage in any potato-growing section in which diseased tubers were planted whenever very moist cool weather prevails during the growing season. It occurs frequently in severe form in the New England States, adjacent Canada, and the Puget Sound district, and less frequently, though often in severe form, in New York, New Jersey, Pennsylvania, Ohio, Michigan, Wisconsin, Minnesota, Iowa, in the mountain districts of the Eastern and Western States, and in Florida on the early crop.

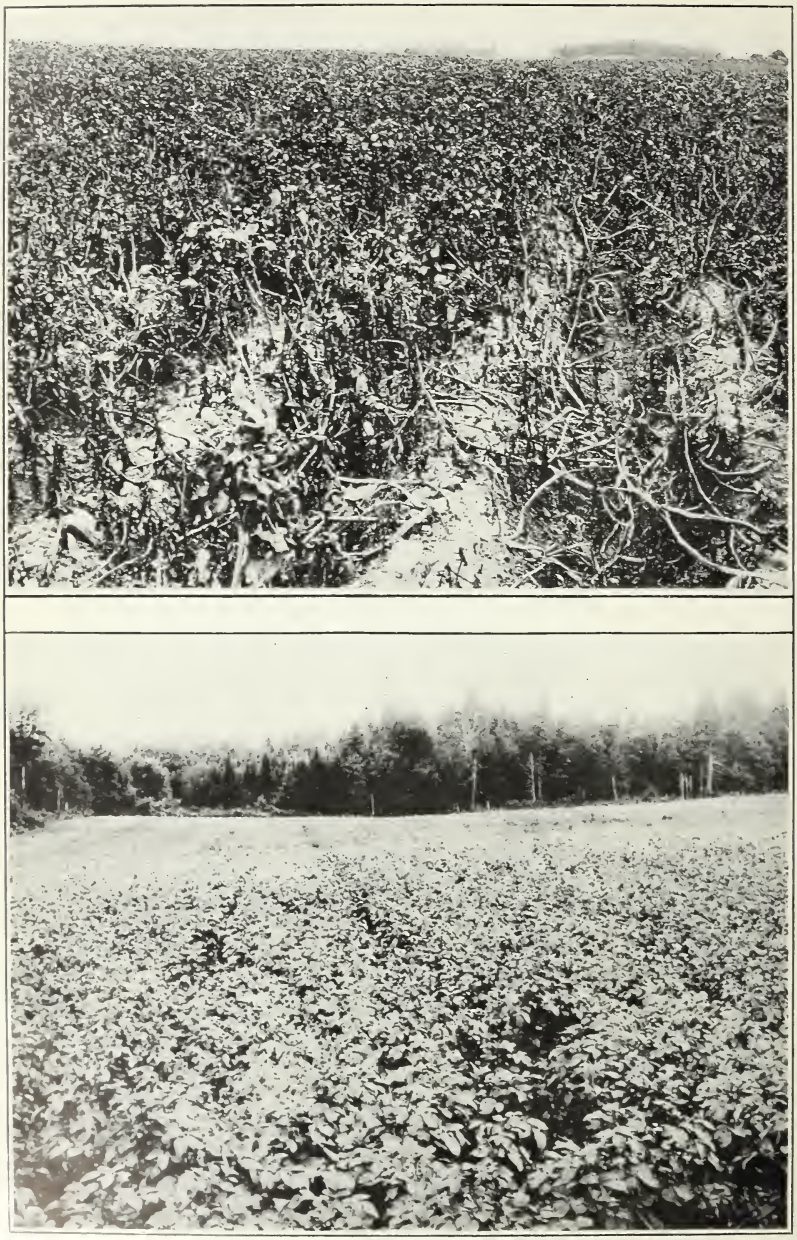
WHERE AND HOW DOES THE FUNGUS GET STARTED IN THE FIELD?

Plants in the field get the disease either from sprouts or vines which grew from diseased seed or from diseased tubers which overwintered in the soil. The fungus itself is not known to overwinter in the soil.

The fungus grows into the sprouts from diseased tubers, and in this way is carried to the surface of the ground unless the sprouts

LATE-BLIGHT: A TUBER ROT OF THE POTATO.

Above: The disease in its initial stage on the potato leaf. Below: External and sectional view of tubers affected with late-blight tuber rot.



CONTROL OF LATE-BLIGHT BY SPRAYING.

Spraying must be thorough. The upper picture shows failure to control the disease, the spraying having been done with average care in midseason only. The lower picture shows perfect control, the result of thorough and frequent spraying throughout the season.

are killed by the fungus before they break through the ground. When the fungus once gets to the surface it may spread on the soil for an inch or so if the ground is very wet, or it may grow on the diseased sprout during wet weather and produce great numbers of spores. These spores may be carried by wind, rain, or insects, such as the potato beetle and slugs, to near-by healthy plants and start new disease spots.

WHERE AND HOW DOES THE FUNGUS GET ON THE TUBERS?

Tubers or other parts of the plant on which the seed bodies or spores of the fungus are lodged are said to be contaminated. The original contamination of growing tubers takes place in the field where the fungus produces its spores on diseased vines. From a diseased vine the spores either fall or are washed to and into the ground by rains, and consequently tubers which are borne within an inch or two of the surface or which are not completely covered with soil readily become covered with the spores of the fungus. In wet seasons the fungus grows so well in heavy soils and produces its spores so freely on and in the soil that all tubers in the ground may become contaminated. The fungus may also grow into the stem end of tubers from a diseased mother plant or from the soil, entering by way of the underground stem that bears the tuber, but this rarely happens.

Tubers also become thoroughly covered with spores of the fungus if they are dug either while the disease is destroying the vines or before frost in a wet field in which the vines were killed by late-blight, or if they are piled in the field and covered with diseased vines. It is probable that all tubers harvested before frost during wet weather in a badly diseased field have some spores on them. Finally tubers may become contaminated in storage and transit, as described later.

A tuber may be contaminated (that is, carry the spores of the fungus on its surface) and still be perfectly sound and healthy and remain so. Before the disease can develop in such a tuber, either in the field or after harvest, the spores of the fungus must sprout and the fungus penetrate the skin of the tuber and establish itself; that is, infection must take place. It is not known how long a time is necessary for tuber penetration under the most favorable conditions for the fungus. According to laboratory and field studies 3 to 24 hours are required for leaf penetration, and it is very probable that at least an equal period of time is required for tuber penetration.

WHAT CONDITIONS FAVOR THE START AND DEVELOPMENT OF THE DISEASE?

The fungus does not grow if moisture is not abundant or if the temperature is below 40° or above 86° F. It grows best at temperatures between 73° and 80° F. and when the air or soil is very

moist. Under these conditions it also produces its seed bodies, or spores, in greatest numbers.

The spores of the fungus do not germinate if the temperature is either below 36° or above 86° F. or if they are dry. They germinate best at about 53° F., either in a film of water or in very moist air. An exposure to dry air for six hours kills them. According to laboratory studies conducted with leaves, 50° to 55° F. are the most favorable temperatures for infection. No studies have been made to determine the most favorable temperature for infection of tubers, but it probably does not vary much from that for leaf infection.

It is possible, therefore, that tubers may be harvested which are contaminated but which never become infected or get the disease. Temperatures below 40° or above 86° F. or dryness will cause such a situation.

Some time must elapse after infection has taken place before visible symptoms of the disease appear, and consequently it may happen that tubers are stored or loaded which look absolutely sound but which have the disease (that is, have become infected) and will develop visible signs later only if temperature and moisture conditions are favorable. The fungus may remain dormant in tubers for months and begin to grow when temperature and moisture conditions become favorable. As already stated, the first sign of the disease on tubers is a slight brownish or purplish discoloration of the skin. It has been found that these discolorations do not appear for three weeks if infected tubers are kept at 64° to 71° F. in moist air. Apparently sound tubers taken from a field where the tops were killed by late-blight were stored at 40°, 55°, and 70° F. and showed 17, 53, and 79 per cent, respectively, of rotting tubers at the end of two months.

The disease does not appear visibly on the leaves for four or five days after infection. If the air is moist and the temperature between 60° and 75° F., the disease then progresses rapidly and may kill the entire plant in one to four days.

DOES LATE-BLIGHT TUBER ROT DEVELOP AND SPREAD AFTER THE TUBERS ARE HARVESTED?

Not only does the disease develop in transit and storage in infected tubers, but it also spreads from diseased to healthy tubers if moisture and temperature conditions are favorable. If the air is very moist and the temperature is above 41° F. the fungus grows out of diseased tubers and produces spores which germinate and lead to the infection of near-by tubers with unbroken skin. It has been found that in moist storage places at temperatures ranging from 60° to 71° F. the diseased spots on tubers may enlarge at the rate of 2 inches in 10 days.

WHAT SHOULD BE DONE WITH DISEASED TUBERS?

Diseased tubers, even though they are unsightly, are fit for food provided the diseased parts are cut away. They should not be stored unless they can be kept dry and the temperature held below 40° F. They should never be used for planting.

HOW CAN THE DISEASE BE CONTROLLED IN THE FIELD AND IN STORAGE?

Diseased tubers should not be used for planting, since they carry the disease to the field.

Spraying with Bordeaux mixture (5 pounds of copper sulphate (bluestone), 5 pounds of stone lime, 50 gallons of water) will kill the fungus and its spores and therefore control the disease in the field if it is done systematically, thoroughly, and early enough with spray machinery which gives 150 pounds pressure or more. (Pl. II.) Whether to spray and when to spray depend upon the locality and the weather. In localities in which blight usually occurs spraying should be begun when the plants are 6 inches high and repeated at intervals of a week or 10 days, or frequently enough to cover the new foliage as it appears.

It is not generally advisable to dig a diseased field while the soil is wet. If a field on light soil becomes badly affected and the weather turns dry and frosting time is near, it is advisable to delay digging until after a frost, which kills both the vines and the fungus.

If a crop grown on very wet, heavy soil becomes diseased during wet weather it may be advisable to dig at once, in order to save some of the crop, even though the chances of losing much of it are very great.

Piles of tubers in the field should not be covered with diseased vines, as the disease may thus be carried from the vines to the tubers.

If tubers in transit or in storage are kept dry and at temperatures between 35° and 40° F. the disease will develop little or not at all.

Those interested in the details of spraying should consult Farmers' Bulletin 868, entitled "How to Increase the Potato Crop by Spraying."